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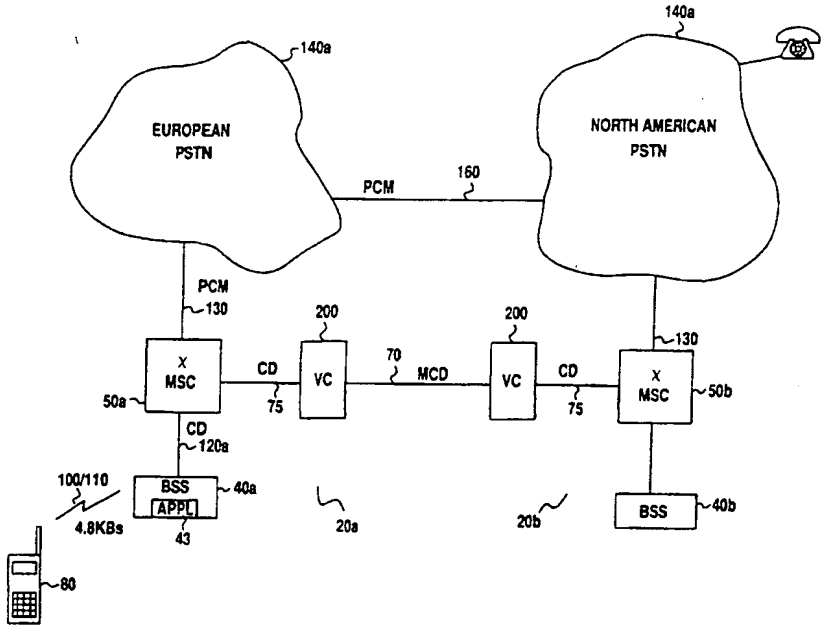
(54) Title: DYNAMICALLY CREATED A-INTERFACE WITHIN A MOBILE NETWORK



(57) Abstract

A call is originated from a mobile station (80) being served by a visited mobile switching center (MSC) and associated with a particular MSC as a home MSC. A base station subsystem (BSS) (40) connected to the visited MSC dynamically establishes an A-interface with an application module within the home MSC transparently through the visited MSC. Thereinafter, all subscriber transmitted data are routed from the serving BSS to the home MSC. The application module within the home MSC then processes the data to provide mobile service to the mobile station.

DYNAMICALLY CREATED A-INTERFACE WITHIN A MOBILE NETWORK

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to a telecommunications system and, in particular, to the establishment of an A-interface within a mobile telecommunications network.

Description of Related Art

With the development of Public Land Mobile Network (PLMN) telecommunications systems, mobile subscribers are able to freely travel within a particular country and utilize their mobile service. Even if the mobile subscriber is roaming within a visited PLMN, the home PLMN associated with the roaming mobile subscriber keeps track of the current location of the mobile subscriber and accordingly makes the necessary arrangements and signaling communications to enable the mobile subscriber to receive and originate calls via another PLMN.

With the globalization of telecommunications networks and related human activities, more advanced mobile communications systems geographically encompassing the whole world are being developed. Such a system enables a mobile subscriber to roam not only within a particular continent or country, but throughout the world. One such system is the Personal Communications System (PCS). Another such system is a satellite based mobile communications system providing global coverage via satellite communications.

For both systems, a number of mobile switching centers (MSC) are strategically placed throughout the world to provide mobile service to a mobile subscriber anywhere in the world. Each MSC is, in turn, associated with one or more base station subsystems (BSS) for providing a radio connection with a mobile station traveling within the MSC coverage area. Once a BSS

in unoptimized use of speech circuits within the connecting telecommunications networks.

Accordingly, it would be advantageous for the European BSS to instead communicate all received data directly with the American MSC associated with the roaming mobile station. As a result, there is a need for a mechanism to break the A-interface that exists, for example, between the European BSS and the application modules within the European MSC, and to enable the European BSS to dynamically establish an A-interface connection with application modules of any other MSC associated with a particular mobile station.

SUMMARY OF THE INVENTION

The present invention discloses a method and apparatus for facilitating optimal communication between a base station subsystem (BSS) serving a roaming mobile subscriber and a home mobile switching center (MSC) associated with that mobile subscriber. All calls communicated by the roaming mobile subscriber are automatically forwarded by the serving BSS to the home MSC regardless of the final destination. In one embodiment, in order to enable the serving BSS to forward all data, e.g., calls, to the home MSC, the roaming mobile subscriber transmits the address representing the home MSC to the serving BSS during initial registration and other procedures. In another embodiment, the roaming mobile subscriber transmits the assigned International Mobile Subscriber Identity (IMSI) number to the serving BSS. Utilizing the received home MSC address or the IMSI number, the serving BSS identifies the home MSC and, thereinafter, routes all data to the home MSC directly.

In one embodiment, the address representing the home MSC is stored within a Subscriber Identity Module (SIM) card associated with the mobile station.

switching center (MSC) address received from the mobile station;

FIGURE 7 is a block diagram of a satellite based mobile communications network maintaining a private signaling and communications link as well as connecting to a Public Switched Telephone Network (PSTN) and a Public Land Mobile Network (PLMN);

FIGURE 8 is a block diagram of a satellite based mobile telecommunications network illustrating the different signaling protocols for interconnecting Satellite Access Nodes (SANs) and for connecting a SAN with a PSTN;

FIGURE 9 is a block diagram of a satellite based mobile communications network illustrating terrestrial network optimization; and

FIGURE 10 is a block diagram of a home MSC maintaining data for mapping each user with its corresponding A-interface link.

DETAILED DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a block diagram of a satellite based mobile communications network 10 providing world-wide mobile service. The satellite based mobile communications network 10, such as the one provided by ICO Global Communications (ICO), is comprised of a number of Satellite Access Nodes (SANs) 20 which are strategically placed throughout the world to provide optimum global coverage. Each SAN 20 is further comprised of a land earth station (LES) 30, a base station subsystem (BSS) 40, and a mobile switching center (MSC) 50. As an alterative, the BSS 40 may contain or be connected to the LES 30. Each MSC 50 is also usually coupled to a visitor location register (VLR, hereinafter collectively referred to as a MSC/VLR 50) 55. In order to store and maintain subscriber data for its servicing subscribers, each SAN 20 is further associated with a centralized database called a home location register (HLR) 60. As an illustration, FIG. 1

the mobile station 80 and one of the BSSs 40, such as a BSS 40c, connected to the serving MSC 50a. Since the BSS 40c is physically connected to the serving MSC 50a, whenever the BSS 40c receives data from the mobile station 80, the BSS 40c has no option but to forward the received data to the serving MSC 50a. The MSC 50a then determines the identity of the mobile station transmitting the data, the destination address of the received data, and accordingly processes the data. This physical connection between an MSC and its associated BSS is called an "A-interface" 120.

In order to properly process and identify the data transmitted by the mobile station 80, the serving MSC 50a must retrieve the requisite subscriber data from the HLR 60 associated with the roaming mobile station 80. The HLR 60 is a centralized database storing all relevant subscriber related information including the current location of the mobile station 80 and the identity of the MSC currently serving the mobile station 80. Accordingly, whenever a particular MSC detects the presence of the mobile station 80 within its coverage area, in a manner similar to the satellite system described above, the visited MSC 50a performs a location update with the HLR 60. The location update is performed to inform the HLR 60 of the mobile station's current location and to retrieve the requisite subscriber information from the HLR. As described above, such retrieved data, including the MSISDN number and billing data, are stored at another centralized database (e.g., visitor location register) associated with the serving MSC 50a and later utilized by the serving MSC 50a to provide mobile service to the roaming mobile station 80. Thereinafter, all calls made from the roaming mobile station 80 are processed by the visited MSC 50a, and calls to the mobile stations are also routed normally through the network towards the visited MSC 50a.

associated with the European MSC 50a. By this, it is meant that the European MSC 50a merely acts as a conduit signal transfer point (STP) and no application module within the European MSC 50a receives or processes the received data. For example, the established voice circuit is transited through the European MSC. The European MSC 50a only acts as a transfer point and routes the received data to a particular MSC specified by the connected BSS.

By always forwarding data to the home MSC 50b associated with the roaming mobile station 80, the same call control and service, including subscriber features and charging, can be maintained and provided by the home MSC 50b regardless of which BSS 40a-40f is currently serving the mobile station 80. Furthermore, more economical and efficient data (i.e., voice) communications can be achieved between the serving BSS 40c and the home MSC 50b.

In order for the serving BSS 40c to automatically forward all received data to the home MSC 50b, two implementations have to be made to the existing mobile telecommunications system: first, the physical limitation imposed by the conventional A-interface has to be removed; and second, the serving BSS must be able to identity the home MSC associated with each mobile station traveling within its coverage area to dynamically establish an A-interface with the identified MSC.

FIGURE 3 is a block diagram of a Common Channel Signaling (CCS) Signaling System No. 7 (SS7) telecommunications protocol for communicating signals and data between two end users. The CCS SS7 telecommunications system, designed using the concepts of packet switching and tailored to conform to the Open System Interface (OSI) model, has been developed for use with both national and international traffic, for local and long-distance networks, for interexchange signaling, and for various types of channels, including both

subscriber features include Automatic Callback, "800" service, and Automatic Recall.

FIGURE 4 is a block diagram of a visited MSC 50a functioning as a serving MSC in a conventional manner to provide mobile service to the mobile station 80. All software and hardware modules and devices included within a particular telecommunications exchange or switch are organized and structured in accordance with the CCS SS7 standard. As an illustration, the physical wire or connection for connecting the MSC 50a with the BSS 40 constitutes the MTP layer 320. Software and hardware modules for receiving the data communicated over the MTP layer to identify the destination address constitute the SCCP layer 310. If the received data are intended for one of its own application modules, the SCCP layer extracts the encapsulated data from the received connection-less packet signal and forwards the extracted data to the appropriate application module residing within the application layer 300. Otherwise, the SCCP layer 310 analyzes the destination address and re-transmits the signal over the MTP layer link. As described above, conventionally, all data received by the serving BSS 40 from the mobile station 80 are automatically forwarded to the connected MSC 50a. The SCCP layer 310a within the visited MSC 50a receives the data from its MTP layer 320a and, after determining that the received data are intended for itself, forwards the data to the application layer 300a. An application module within the application layer 300a then identifies and processes the received data to provide appropriate mobile service to the mobile station 80. Such a process may include performing a location update with the HLR 60 associated with the mobile station 80. Another process may be to retrieve the requisite subscriber information from the associated HLR 60. Accordingly, all BSS forwarded data are received and filtered by the application layer 300a before being processed or transmitted to another node, e.g., HLR or

In accordance with the teachings of the present invention, by enabling the serving BSS to specify a network address representing a different MSC than the serving MSC physically connected to the serving BSS, the visited MSC 50a merely acts as a conduit Signal Transfer Point (STP) and the BSS transmitted data are instead forwarded by the visited MSC to a destination MSC specified by the serving BSS. Accordingly, even though the visited MSC 50a is physically connected to the serving BSS 40, it is the remotely connected home MSC 50b which processes the data and controls the call. Therefore, a dynamically established A-interface 330 between the home MSC 50b and the serving BSS 40 is created.

Accordingly, in order to enable the serving BSS 50 to communicate all data received from the mobile station 80 with the home MSC 50b, the serving BSS 50 must be able to identity the home MSC 50b associated with the roaming mobile station 80 without the help of the visited MSC 50a. Therefore, an application module 43 within the visited BSS 40 receives an identification number from the mobile station 80 and determines the network address representing the home MSC 50b associated with the mobile station 80. In accordance with the teachings of the present invention, there are a number of different identification numbers that can be used to identity the home MSC 50b. One such number is the International Mobile Subscriber Identity (IMSI) number associated with the mobile station. Another such number is the network address representing the home MSC.

FIGURE 6 is a block diagram illustrating a serving BSS, such as the European based BSS 40, transmitting a location update signal 230 using a home MSC address received from the mobile station 80. Whenever the mobile station 80 turns on its unit for the first time or travels into the coverage area provided by the European BSS 40, the mobile station 80 identifies itself and registers with the home MSC 50b by transmitting its identification number

Since the home MSC address is independently stored within the mobile station 80, in case the majority of calls are being directed to a different continent or MSC coverage area, the mobile subscriber may freely update the memory register to store the new address representing the new home PLMN. Furthermore, the memory register can be changed to reflect the network address of the last MSC used by the mobile station. Thereinafter, all subsequent calls are processed through the newly designated MSC. As a result, the mobile subscriber may have one MSC as the home MSC and another MSC as the "control" MSC where all calls are processed. This is possible because the mobile station transmits two different numbers when initially registering with the serving BSS. A first number, such as an IMSI number, uniquely identifies the mobile subscriber and a second number, such as an MSC network address, uniquely identifies the home or "control" MSC.

As an alternative, the existing IMSI number transmitted by the mobile station 80 during initial registration can be used by the serving BSS 40 to communicate a SCCP based signal with the home MSC 50b. Since a series of IMSI numbers are assigned to a particular MSC or HLR, by analyzing the received IMSI number, the serving BSS 40 and the connected PSTNs 140a-140b are able to ascertain the identity of the home MSC 50b. Accordingly, after receiving the IMSI number from the newly registering mobile station 80, the serving BSS 40 transmits a SCCP based signal 230 over an SS7 network to the home MSC 50b. The SCCP based signal 230 containing the received IMSI number as the called party address is routed through the conventional PSTNs and communicated from the European PSTN 140a to the North American 140b over the international trunk line 70. As a result, the North American MSC 50b is notified of the mobile station's new location and the identity of the new BSS 40 currently serving the mobile station.

extracts the IMSI number identifying the mobile station 80 from the received signal and performs the paging with the extracted IMSI number. The mobile station 80 monitoring the paging channel (PCH) responds to the paging identified by its IMSI number. Once the mobile station 80 responds to the paging, the BSS 40 notifies the MSC 50b and a speech channel connecting the incoming call with the mobile station 80 is accordingly established.

FIGURE 7 is a block diagram of a Satellite based mobile communications network maintaining a private signaling and communications link as well as connecting to an existing PSTN or PLMN. A speech or data connection from mobile station 80 to another telecommunications terminal can be established via a number of different routes. A data signal from the mobile station 80 is initially detected and received by one of the satellites orbiting the earth atmosphere 90a via a first radio link 100. The received data are then downloaded to a land earth station (LES) 30a serving in the mobile station's current location via a second radio link 110. The downloaded subscriber data are then forwarded to an associated Base Station Subsystem (BSS) 40a via a communication link 115a. As an alternative, as described above, the LES 30a may also be part of the BSS 40a. From the serving BSS 40a, there are basically two different ways the received data can be communicated to a destination terminal or node, such as the home MSC 50b, on another continent. The serving BSS 40a can connect directly to the associated Public Switched Telephone Network (PSTN) 140a via the connected MSC 50a. The associated PSTN 140a can then route the data to the destination node via conventional PSTN links. As an illustration, if the serving BSS 40a and MSC 50a serve the European continent, the received subscriber data can be forwarded to the European PSTN 140a via a communications link 130. The European PSTN 140a, such as an International Telecommunications Union (ITU) based

first SAN 20a with a PSTN 140a. There are additional reasons for preferring to communicate over the privately maintained SAN network as much as possible before connecting to a PSTN. First, as described above, the privately maintained SAN network links are already accessible and paid for by the SAN network provider. Furthermore, it provides a direct communications link between the serving BSS and the home MSC. Moreover, the capacity for communicating data over the privately maintained SAN network 70 is much greater than communicating over conventional telecommunications networks.

In accordance with the Global System for Mobile (GSM) communications standard, the communications within and between PSTNs 140 are accomplished using 64 kilo-bits per second (Kb/s) Pulse Code Modulation (PCM) technology. PCM is a technique for transmitting a multiplexed voice or data stream over a T-1 or E-1 digital communications link 130. A PCM E-1 link includes up to thirty-two 64 Kb/s channels or paths. Out of the thirty-two channels, two are used for communicating control signals, and the remaining thirty channels are used for data communication. Each 64 Kb/s channel is required to carry a single call, and consequently, up to thirty calls can be communicated over the PCM E-1 link. On the other hand, the speech and data rate for each call communicated between the mobile station 80 and the BSS 40a via the air interface therebetween is 4.8 Kb/s. The 4.8 Kb/s data are then decoded into an 64 Kb/s data stream. Each 64 Kb/s data stream is in turn placed in a single 64 Kb/s channel and communicated from the BSS 40a to the serving MSC 50a over a coded (CD) communications link 120. Accordingly, while communicating with the PSTN 140, at most, only thirty simultaneous calls can be transmitted from the BSS to the PSTN via the thirty 64 Kb/s PCM E-1 communications link 130. However, by communicating the received 8 Kb/s data stream over the private SAN network 70, the

North American MSC 50b, by utilizing subscriber information retrieved from the HLR 60, the serving MSC 40b establishes a call connection with a conventional wireline terminal 170 connected to the PSTN 140 via the PCM communications link 130.

Similarly, all data transmitted by the home MSC 50b towards the serving BSS 40 are also communicated over the MCD E-1 communications link 70. Once the serving BSS 40 receives the data, it is transmitted to the roaming mobile station 80 via a radio channel, such as a traffic channel (TCH).

FIGURE 10 is a block diagram of a home MSC 50a maintaining data for mapping each user (e.g., application layer module for processing a call connection) with its corresponding A-interface link. In case one of the associated mobile subscribers is roaming within Europe and being serving by the BSS 40a, another mobile subscriber is roaming within North American and being served by the BSS 40b, and yet another one is roaming within Asia and being served by the BSS 40c, the home MSC 50 is no longer communicating data to a single BSS. Accordingly, depending on the call, the home MSC 50 has to determine which A-interface link 330a-330c should be used to communicate the data to the appropriate BSS 40a-40c.

When a target BSS or location is identified, conventionally, simply identifying the circuit which is permanently connected to the BSS associated with that location (e.g., the conventional "A-interface") enabled the serving MSC to communicate data to the target BSS. Since such dedicated circuits do not exist in the present invention, the association must now be to a route which leads to the establishment of an on-demand or dynamically created circuit to the needed target BSS or location. An administration module 350 within the home MSC 50a determines which association or mapping needs to be established in order to communicate speech data 390 received from a telecommunication user to one of the BSSs

Although preferred embodiments of the method and apparatus of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

updating, by said second MSC, a home location register (HLR) serving said mobile station with said current location.

4. The method of claim 3 wherein said step of sending said signal indicating said current location further comprises the step of sending a location update signal from said first BSS to said second MSC.

5. The method of claim 4 wherein said location update signal comprises a Signal Connection Control Part (SCCP) based signal transmitted over an existing Signaling System No. 7 (SS7) telecommunications network connecting said first BSS to said second MSC.

6. The method of claim 3 wherein said step of transmitting said address representing said second MSC from said mobile station further comprises the initial step of retrieving said address from a subscriber identity module (SIM) attached to said mobile station.

7. The method of claim 3 wherein said address representing said second MSC includes an International Mobile Subscriber Identity (IMSI) number associated with said mobile station.

8. The method of claim 3 wherein said address presenting said second MSC includes a network address assigned to said second MSC.

9. The method of claim 1 wherein said step of routing said received data from said first BSS to said second MSC further comprises the step of transmitting said data over a dedicated link directly connecting said first MSC with said second MSC.

forwarding said request to originate said call connection from said BSS to said MSC;

determining a called party associated with said request by said MSC; and

establishing a call connection towards said called party by originating a call setup request to a connected Public Switched Telephone Network (PSTN) by said MSC.

16. The method of claim 15 wherein said BSS is directly connected to a visited MSC and wherein said step of forwarding said request from said BSS to said MSC further comprises the step of forwarding said request over a dedicated link connecting said visited MSC with said MSC.

17. A system for delivering data from a mobile station to a destination telecommunications terminal within a telecommunications network, said mobile station being served by a first base station subsystem (BSS) and a first mobile switching center (MSC) and said mobile station being associated with a second MSC as a home MSC, said system comprising:

an application module within said second MSC for providing mobile service to said mobile station;

means for receiving data transmitted by said mobile station at said first BSS;

means for routing said received data from said first BSS to said application module within said second MSC transparently through said first MSC;

means for recognizing said data at said application module within said second MSC;

means for routing said data from said second MSC to said destination telecommunications terminal.

18. The system of claim 17 further comprises means for dynamically establishing an A-interface between said

24. The system of claim 19 wherein said address presenting said second MSC includes a network address assigned to said second MSC.

25. The system of claim 17 further comprising a dedicated link connecting said first MSC with said second MSC and wherein said means for routing said received data from said first BSS to said second MSC further comprises means for transmitting said data over said dedicated link.

26. A method for establishing a call connection from a mobile station to a destination terminal within a telecommunications network, said mobile station being served by a first base station subsystem (BSS) and a first mobile switching center (MSC) and associated with a second MSC as a home MSC, said method comprising the steps of.

receiving a request from said mobile station at said first BSS to establishing a call connection towards a called party terminal;

establishing a first call connection from said first BSS to said second MSC transparently through said first MSC without analyzing an address associated with said called party terminal;

analyzing said address associated with said called party terminal by said second MSC; and

establishing a second call connection from said second MSC to said called party terminal by transmitting a call setup request by said second MSC.

27. The method of claim 26 wherein said first BSS is located in one geographic area and said second MSC is located in another geographic area and said first MSC and said second MSC are connected via a dedicated link.

28. The method of claim 27 wherein said dedicated link comprises a Multiplex coded (MCD) E-1 link.

FIG.1

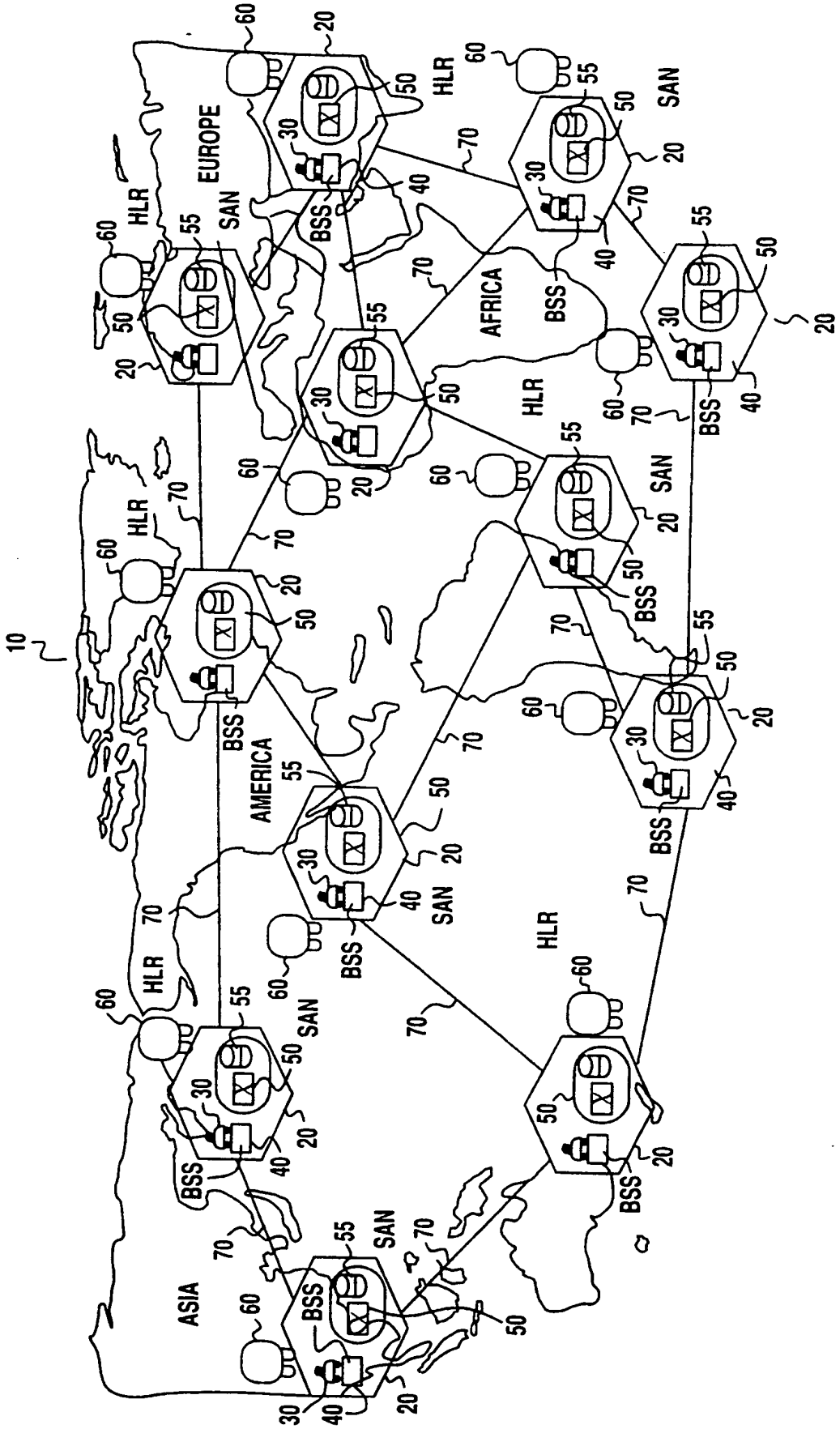
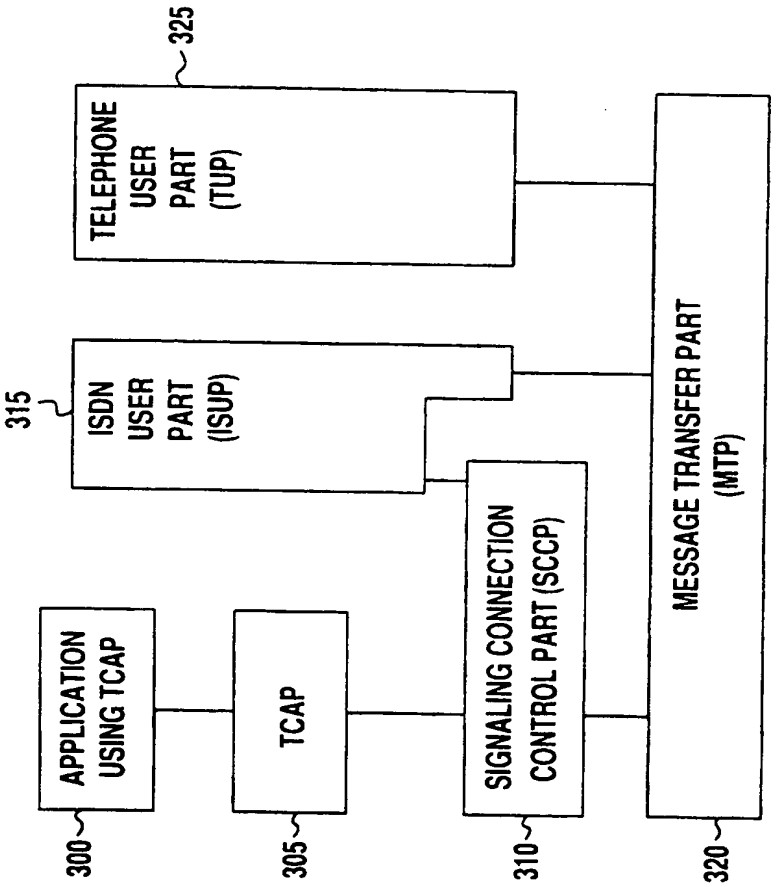


FIG.3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315
ISDN USER PART (ISUP)
APPLICATION USING TCAP
TCAP
SIGNALING CONNECTION CONTROL PART (SCCP)
MESSAGE TRANSFER PART (MTP)
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305
310
320

FIG.5

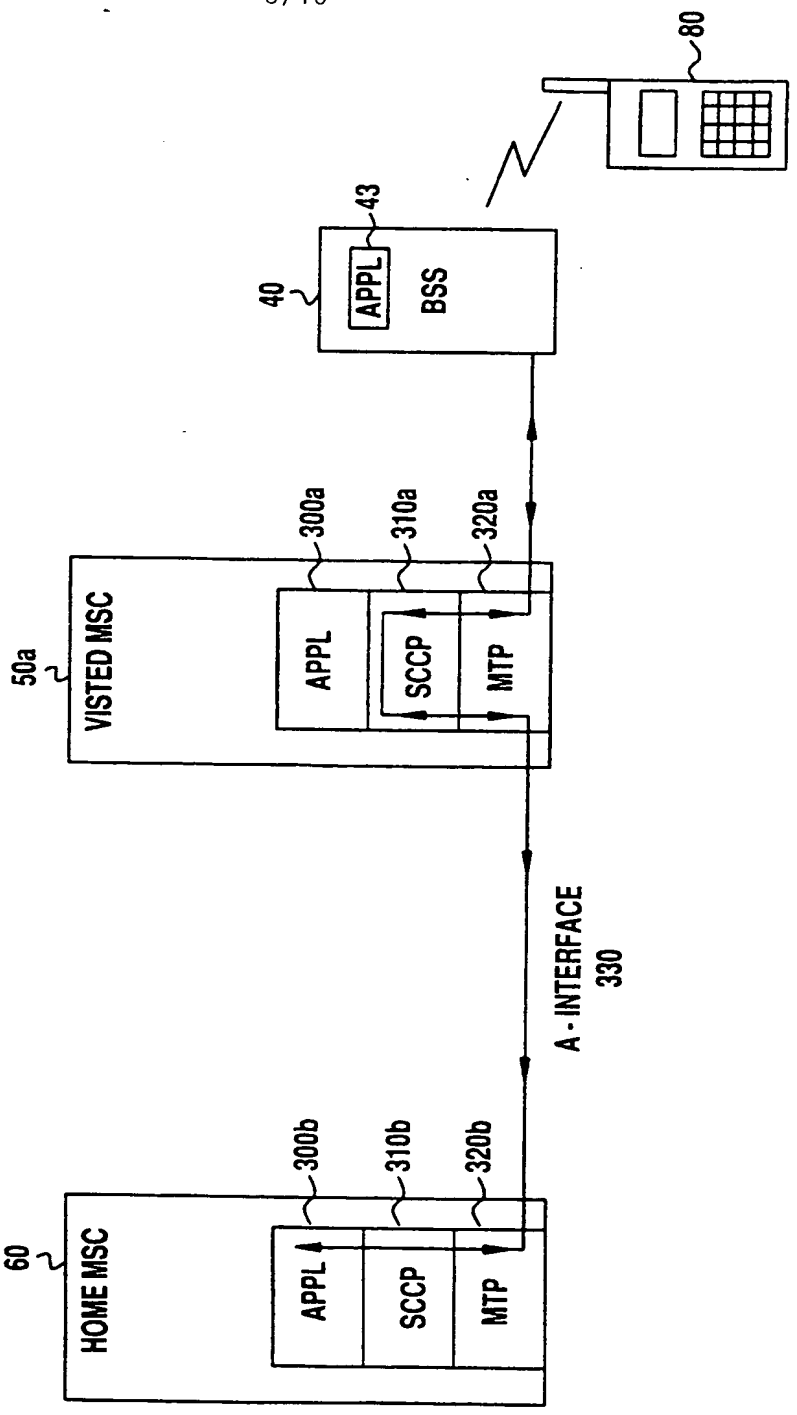


FIG.7

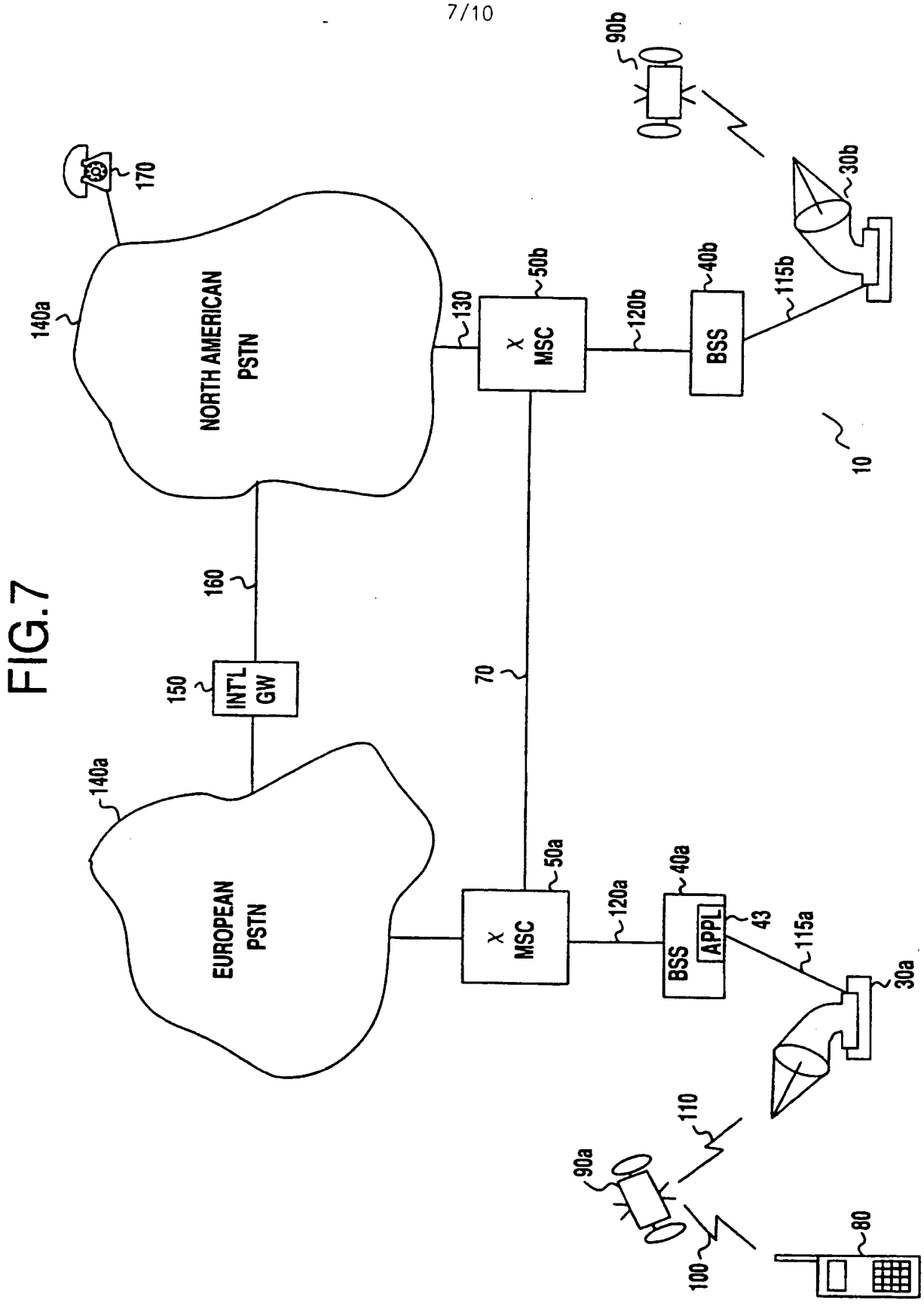
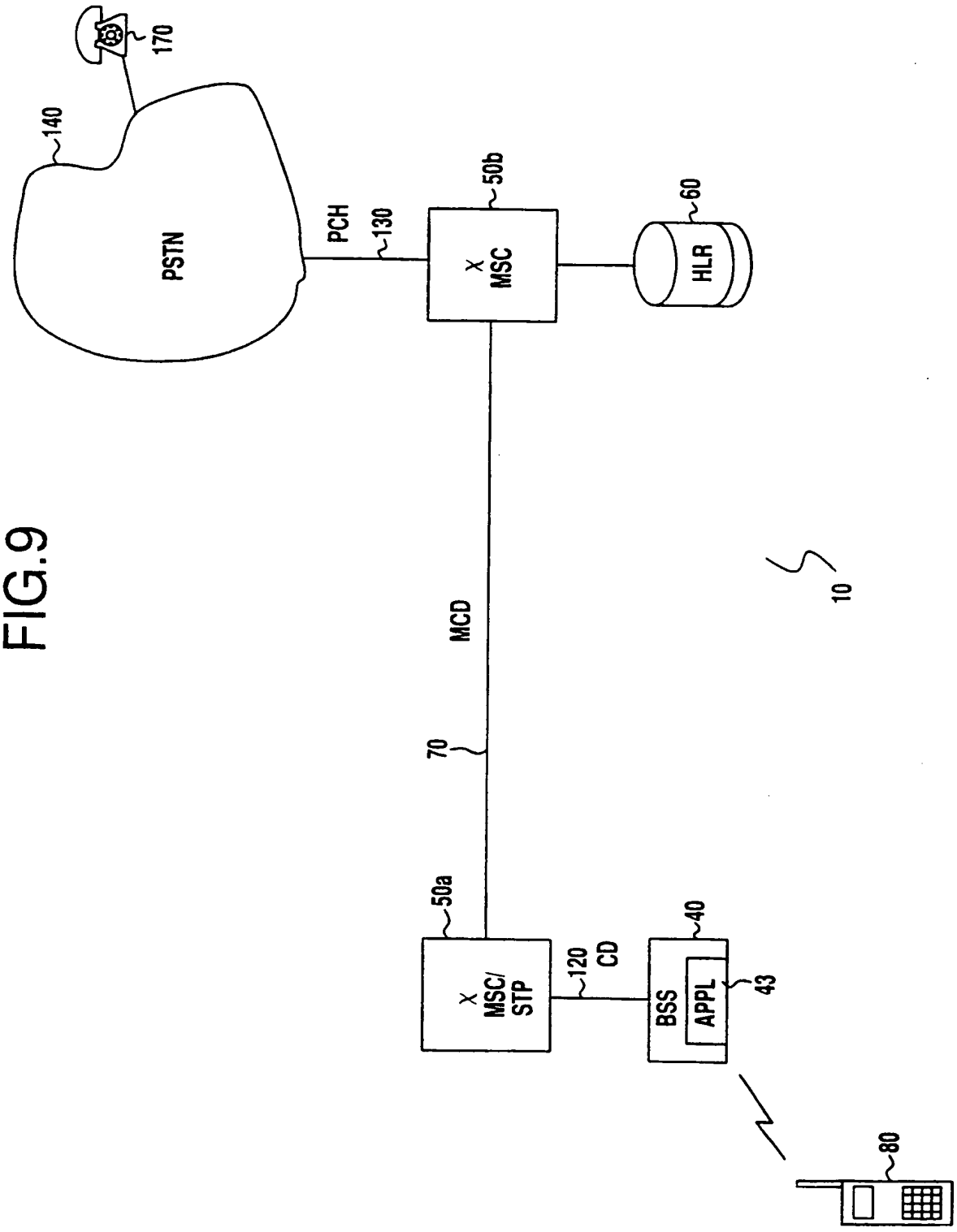


FIG.9


170
140
PSTN
PCH
130
50b
X MSC
60
HLR
MCD
70
10
50a
X MSC/ STP
120
CD
40
BSS
APPL
43
80

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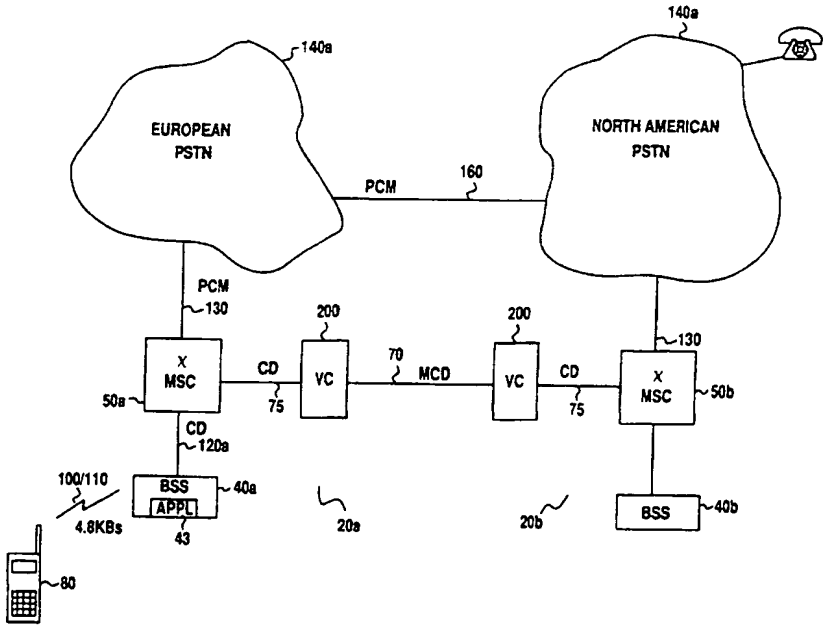

(57) Abstract

A call is originated from a mobile station (80) being served by a visited mobile switching center (MSC) and associated with a particular MSC as a home MSC. A base station subsystem (BSS) (40) connected to the visited MSC dynamically establishes an A-interface with an application module within the home MSC transparently through the visited MSC. Thereinafter, all subscriber transmitted data are routed from the serving BSS to the home MSC. The application module within the home MSC then processes the data to provide mobile service to the mobile station.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/38

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
A	EP 0 708 571 A (AT&T) 24 April 1996 see page 3, column 3, line 6 - page 9, column 16, line 35; figures	1-29
A	US 5 497 412 A (LANNEN ET AL.) 5 March 1996 see column 4, line 42 - column 18, line 54; figures	1-29
A	WO 96 07277 A (NOKIA) 7 March 1996 see page 7, line 13 - page 16, line 24; figures	1-29
A	WO 95 28063 A (NOKIA) 19 October 1995 see page 7, line 23 - page 20, line 26; figures	1-29

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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18 August 1998	27/08/1998

Name and mailing address of the ISA	Authorized officer
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